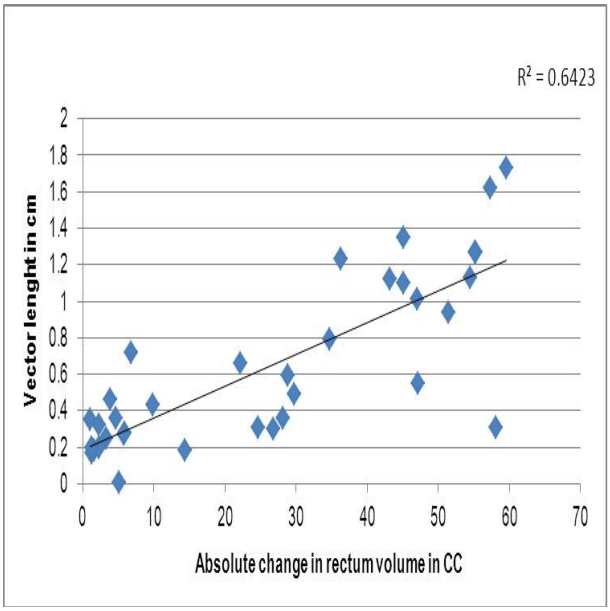
(ART) to account for daily variations in bladder filling. Prior to each fraction, a conebeam CT (CBCT) is acquired and registered to the planning CT using a Chamfer algorithm (Elekta XVI 4.5). A dedicated RTT chooses the best fitting plan from a library of five plans. When none of the five plans fit the bladder volume, fine-tuning of the bony anatomy registration is performed (tweak), in order to optimize target coverage.
A tweak introduces an inter observer error and is a challenging time consuming part of the online CBCT registration workflow. We hypothesized that the rectum volume had a large influence on fine-tuning. The aim of this study was to investigate whether a significant correlation exists between rectum volume and performed tweak.

Material and Methods: Prior to treatment, the tumor was marked during cystoscopy with lipiodol or hydrogel. Two planning CTs were acquired: full bladder 100%; empty bladder 0%. A structure-based algorithm was used to create five different target volumes: 0%, 33%, 67%, 100%, and 133%, to create five different VMAT plans. The bladder and lymph nodes were treated to 40 Gy, the tumor up to 55 Gy, in 20 fractions using a simultaneously integrated boost. If none of the plans resulted in a good coverage of the bladder volume, the dedicated RTT had three options. The first two options were to instruct the patient to drink more and/or defecate: a 100% bladder filling is preferred. The third option was to perform a tweak.
A tweak should not exceed the PTV margins: 7 mm L-R (X), 8 mm C-C (Y) and A-P (Z) and is restricted by adequate coverage of the high dose area, visible through the lipiodol or hydrogel. This area is considered clinically more important compared to the elective lymph nodes.
189 CBCTs from 10 patients were analyzed. Bladder and rectum volumes from both CT and CBCT were recorded. The differences in rectum volume between CT and each CBCT were calculated, as well as the mean rectum volume (compared to the planning CT) and the vector length of the tweak (see figure 1). The correlation (R^2) between the rectum volume and the tweak vector was calculated.



Results: For fractions without a tweak the mean relative rectum volume was 99% compared to 79% for fractions in which a tweak was performed. The number of times each plan was chosen and the times a tweak was performed are shown in Table 1.

VMAT Plan	How many times chosen	Fine tuning performed	R^2
0% (empty bladder)	5	4	0.60
33%	38	14	0.10
67%	89	35	0.64
100% (full bladder)	42	17	0.37
133%	15	3	0.53
Total	189	73	

Conclusion: A significant correlation was found between the vector length of the tweak and rectum volume difference between full bladder CT and CBCT. Also tweaking was necessary less often when the rectum volume remained stable. Further research is necessary to identify a range of rectum volumes that will probably remain stable during the course of treatment.

OC-0472

Patient preference-driven plan optimisation for shared decision making in anal cancer radiotherapy

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Purpose or Objective: The traditional paradigm for inverse planning does not always deliver a Pareto-optimal dose distribution. In addition, trade-offs between different organs at risk are often necessary. In a clinical setting centered on shared decision making (SDM) between patients and their physicians, we suggest that individual preferences could be incorporated into plan selection based on a family of optimal plans. We present interim results from an efficient workflow for plan generation with trade-off selection, based on multi-criteria optimization (MCO).

Material and Methods: In this pilot study, dose plans were retrospectively generated for four representative anal cancer patients. All were treated with intensity-modulated radiotherapy with a standard regimen (60.2 Gy simultaneous-integrated tumor boost with 50.4 Gy to elective nodes, in 28 fractions, *high dose regimen*) and physician-defined organ-sparing priorities. In the first alternative plan generation, we optimized for minimum acceptable target volume coverage and same organ-sparing priorities, but assumed that the patient voluntarily foregoes the last three fractions of the standard regimen (tumor and nodal dose lowered by 6.45 Gy and 5.4 Gy, respectively, *low dose regimen*). Resulting changes in 2-year local tumor control probability were estimated using a model by Muirhead et al (Radiother Oncol 2015;116: 192–196). In the second round of alternative plan generation, we used MCO to search the phase space of optimal plans at the shorter regimen that would maximize sparing of the bowel at the expense of the bladder (*bowel sparing regimen*), and vice versa (*bladder sparing regimen*). In this way, we simulated the maximum span of dose distributions available for individualized patient preferences in regards to toxicity avoidance.

Results: Figure 1 demonstrates dose distributions for a single patient for the high dose, low dose, bowel sparing, and bladder sparing regimen. Dose metrics for bladder and bowel are shown in Table 1. All dose plans had clinically acceptable target coverage, and were deemed satisfactory by a senior oncologist. Considerable reduction of dose to the bowel was possible, not only by reduction in prescription dose (ΔV45Gy=289 ccm) but also further by prioritization of bowel in the plan optimization (ΔV45Gy=308 ccm). This resulted in bladder dose metrics no better than those for the high dose regimen. The reverse was seen for bladder sparing plans.

Overall, the possibility of sparing the bowel at the cost of extra dose to the bladder and vice versa was demonstrated. The estimated change in primary tumor control for high versus low dose regimen was less than 1% for early stage tumors and approximately 5% for late stage tumors.

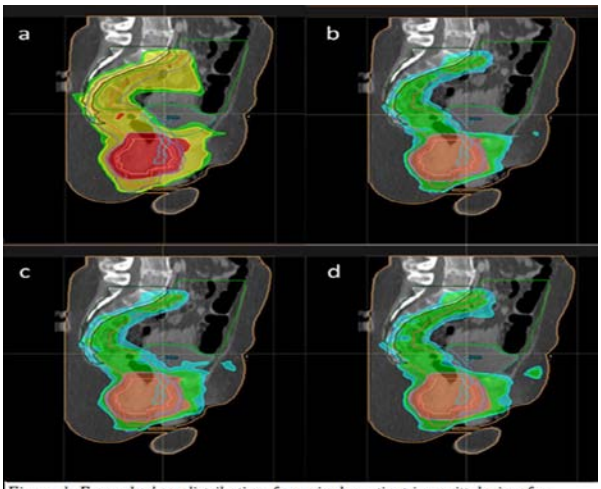

Figure 1. Example dose distribution for a single patient in sagittal view for for the high dose regimen (a), low dose regimen (b), bowel sparing regimen (c), and bladder sparing regimen (d). Dose color wash showing the two dose levels and the 45 Gy bowel dose constraint. Red: 57.19 Gy (95 % of 60.2 Gy). Yellow: 47.50 Gy (95 % of 50.4 Gy). Green: 45 Gy (bowel constraint). Orange: 51.06 Gy (95% of 53.75 Gy). Turquoise 42.75 Gy (95 % of 45 Gy).

	Bladder [%]				Bowel [ccm]			
	Rel. diff [%]		Abs. diff [% points]		Rel. diff [%]		Abs. diff [ccm]	
Plans	V35Gy	V50Gy	V35Gy	V50Gy	V30Gy	V45Gy	V30Gy	V45Gy
High vs. low	0.9	88.0	0.8	9.7	1.9	51.3	30.7	288.6
High vs. low, bladder sparing	27.3	91.3	19.8	10.3	-0.8	35.6	1.8	205.8
High vs. low, bowel sparing	-20.8	83.5	-6.1	8.8	8.0	54.4	86.4	308.1

Table 1. Relative and absolute mean differences for dose to the bladder and bowel for four patients (two men and two women). Dose metrics from the high dose regimen plans are compared to the low dose regimen, bowel sparing regimen and bladder sparing regimen, respectively.

Conclusion: There is room in the optimization space for incorporation of patient outcome and toxicity preferences. This opens for SDM for anal cancer patients. The study is to be expanded, with results for a total of 22 patients to be presented at ESTRO 2016.

Poster Viewing : 10: Physics: Functional Imaging II

PV-0473

Diagnostic and predictive values of quantitative analysis on T2-w and ADC map MRI in prostate cancer

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Purpose or Objective: To explore the ability of quantitative prostate T2-weighted (T2-w) and apparent diffusion coefficient maps (ADC) MRI using Haralick texture features: i) to differentiate prostate cancer (PC) from healthy tissues; ii) to be correlated with Gleason score; iii) to predict biochemical recurrence after external beam radiotherapy (RT) for prostate cancer.

Material and Methods: Tumor and prostate zones were segmented on co-registered T2-w and ADC on two pre-treatment 3.0T MRI from 83 patients with a median age 67 years (range 50-82 years) and a median pre-treatment PSA of 9.8 ng/ml (range 3.4-48.0 ng/ml). 9 (11%) tumors were localized in the transitional zone (TZ) and 74 (89%) in the peripheral zone (PZ). Tumors were clinically staged as follows: 13% of T1, 46% of T2 and 41% of T3. Gleason scores were as follows: 6 (27%), 7 (51%), 8 (20%) and 9 (2%). They were 2% of low-risk, 33% of intermediate-risk and 65% of high-risk tumors according to D'Amico risk group classification. Almost all patients received standard treatment consisting in IMRT (100%) with IGRT (94%) associated with hormonal therapy in 53% of the patients. After a median follow-up of 47 months (range 19-65 months), 11 patients had biochemical recurrence. A total of 114 grey-leveled features (first order, gradient-based and second order Haralick texture characteristics) and 4 geometrical features (maximal tumor diameter, maximal tumor perimeter, maximal tumor area and tumor volume) were extracted on normalized T2-w and ADC and were analyzed. Statistical analyses were performed using Wilcoxon signed-rank test, Spearman's correlation coefficient, Harrell's C-index, Kaplan-Meier curves and univariate Cox regression analysis.

Results: i) 56 out of 57 T2-w and 46 out of 57 ADC grey-leveled features were significantly different between tumor and prostate tissues in the PZ and 25 out of 57 T2-w and 37 out of 57 ADC features in the TZ ($p<0.05$). ii) 5 T2-w features and 4 ADC features were significantly correlated with Gleason score, all were Haralick texture features. iii) T2-w features that significantly predicted ($p<0.05$) biochemical recurrence were: maximal tumor diameter/perimeter/area/volume, Kirsch gradient operator, normalized mean and standard deviation of signal intensity and 8 Haralick texture features (Difference Variance, Contrast, Inverse Difference Moment, Difference Entropy, Information Measure of Correlation, Sum Average, Sum Variance and Sum of Squares). Only normalized mean value on ADC was significantly predictive of biochemical recurrence.

Conclusion: Quantitative analysis using Haralick texture characteristics on T2-w MRI are good features: i) to differentiate prostate cancer from healthy tissues, ii) for Gleason score assessment and iii) to predict biochemical recurrence after RT. Geometrical characteristics extracted from T2-w are also good predictors of biochemical recurrence after RT.

PV-0474

Comparison of DCE MRI and FMISO-PET kinetic parameters in head and neck cancer patients

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Purpose or Objective: Tumour hypoxia is associated with poor response to radiotherapy. Comprehensive hypoxia assessment through [18F]-fluoromisonidazole (FMISO) PET imaging requires quantitative techniques, such as dynamic acquisition. However, dynamic FMISO PET protocols might be simplified by using DCE-MRI imaging in addition to static FMISO-PET. The aim of this work was to compare FMISO and DCE-MRI kinetic parameters by means of correlation analysis.

Material and Methods: This study was done on N=6 head and neck cancer patients, who were imaged dynamically with FMISO-PET and DCE-MRI on the same day. Images were registered and analyzed for kinetics on a voxel basis. FMISO-